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SUMMER EMERGING EPHEMEROPTERA, PLECOPTERA, AND TRICHOPTERA OF ABRAMS CREEK, GREAT SMOKY MOUNTAINS NATIONAL PARK

R. Edward DeWalt and B. D Heinold

Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, Illinois 61820, U.S.A. (e-mail: edewalt@inhs.uiuc.edu)

Abstract.—Abrams Creek drainage was surveyed for adult mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) during summer 2001 as part of the All Taxa Biodiversity Inventory in the Great Smoky Mountains National Park (GRSM). Nine reaches were collected, up to five times, using primarily ultraviolet light trapping. Of the 35,710 specimens examined, 164 species resulted. These consisted of 35 species of mayflies, 36 stoneflies, and 93 caddisflies. Eight species are new to Tennessee, while 39 are new GRSM records. Three rarely collected mayflies, *Epeorus vitreus* (Walker), *Leucrocuta thetis* (Traver), and *Nixe spinosa* (Traver), were taken. Rare caddisflies included *Ceratopsyche macleodi* (Flint), *Cheumatopsyche helma* Ross, *Hydroptila chattanooga* Frazer and Harris, *H. talladega* Harris, and *Chimarra augusta* Morse. No rare stoneflies were collected. Additional specimens of two undescribed (but known to specialists) species were taken in *Goera* (Trichoptera) and *Isoperla* (Plecoptera). Specimens of *Hydroptila* nr. *amoena* Ross (Trichoptera) and a *Caenis* nr. *mccafferti* Provonsha (Ephemeroptera) are possibly new to science, but require more specimens and study. More effort concentrated in southwestern GRSM and in Ephemeroptera and Trichoptera should yield additional significant records.

Key Words: Ephemeroptera, Plecoptera, Trichoptera, Great Smoky Mountains National Park, All Taxa Biodiversity Inventory

The Great Smoky Mountains National Park (GRSM) straddles the border between Tennessee and North Carolina, USA. It resides in one of the most species-rich temperate zones in the world and has been designated as an International Biosphere Reserve (Sharkey 2001). The National Park Service, aided with funding and logistical support by the non-profit Discover Life in America (DLIA), has been documenting the presence, distribution, and biology of GRSM species as part of an All Taxa Biodiversity Inventory (ATBI). The many benefits of the ATBI project have been documented by Sharkey (2001).

Abrams Creek is the westernmost drainage in the GRSM and is entirely contained within Blount County, Tennessee. It arises from elevations near 1,300 m along the Tennessee and North Carolina border and empties into Lake Chilhowee, an impoundment of the Little Tennessee River at approximately 320 m elevation. This drainage is largely pristine in its headwaters but has been cleared of its forested riparian zone within its middle third, an area referred to as Cades Cove. One Cades Cove reach is a "losing stream" at times, where porous bedrock allows water to escape the channel, only to resurface downstream. Beyond

Table 1. Streams, elevation, coordinates, and dates visited for nine repeatedly sampled sites in the Abrams Creek drainage of the Great Smoky Mountains National Park, summer 2001. All dates are ultraviolet trap events unless otherwise noted.

Stream and Description	m asl	Latitude	Longitude	Dates Visited
Anthony Cr., Anthony Cr. Trail	821	35.5868	83.7516	UV 5/27; Sweep 5/26, 6/9, 7/6
Abrams Cr., Cades Cove CG	584	35.6047	83.7757	5/24, 6/9, 6/19, 7/5, 7/17
Abrams Cr., Sparks Ln.	553	35.6025	83.7939	5/25, 6/7, 6/19, 7/6, 7/17
Abrams Cr., Abrams Falls Trlhd.	532	35.5921	83.8520	5/25, 6/8, 6/18, 7/6, 7/18
Mill Cr., Abrams Falls Trlhd.	540	35.5901	83.8522	6/6, 6/18, 7/6, 7/18
Forge Cr., Gregory Rg. Tr., CG 12	733	35.5472	83.8321	Sweep 5/25; UV 5/26, 6/7, 6/21, 7/7, 7/20
Trib. Forge Cr., Gregory Rg. Tr.	715	35.5485	83.8349	Sweep 5/25; UV 5/26, 6/7, 6/21, 7/7, 7/20
Trib. Forge Cr., Parson Br. Rd.	671	35.5588	83.8546	5/27, 6/9, 6/19, 7/7, 7/18
Abrams Cr. at Abrams Cr. CG	367	35.6103	83.9327	5/29, 6/10, 6/20, 7/8, 7/22

Cades Cove the stream begins a steep descent through a narrow canyon culminating at Abrams Falls, a bedrock outcropping some 4–5 m high. The stream eventually flattens near its mouth, providing long placid runs and pools, interspersed by short riffles.

Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), hereafter collectively referred to as EPT, are common inhabitants of streams throughout much of the world. In North America, they are especially diverse in the southeastern United States, where they have undergone much speciation, due in part to the relatively stable geology and climate of the area (Brigham et al. 1982). Their current status and risks to survival in the Southeast have been reviewed by Morse et al. (1993).

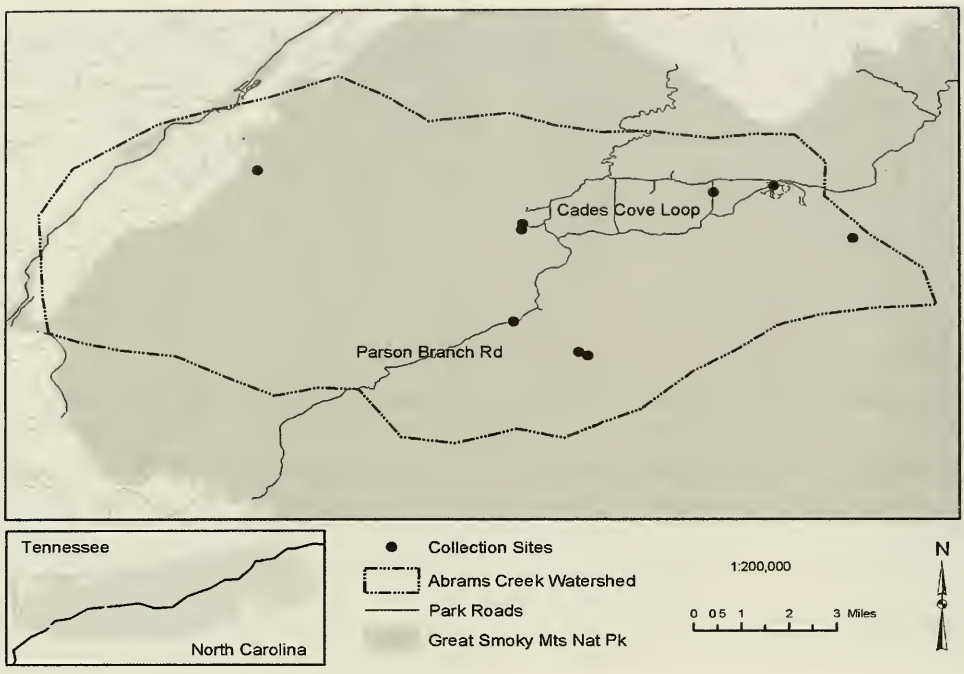
EPT species have a wide range of tolerance to organic pollution and habitat alteration, with many species being extremely intolerant of environmental change. As an ecological indicator, the number of EPT taxa is an efficient measure of stream health, provides a surrogate for more costly measures of ecosystem function, and has the ability to monitor habitat specific impacts (Barbour et al. 1992, Lenat and Penrose 1996, Wallace et. al. 1996). Ecological tolerance values have been established for many commonly encountered taxa in the Southeast (Lenat 1993).

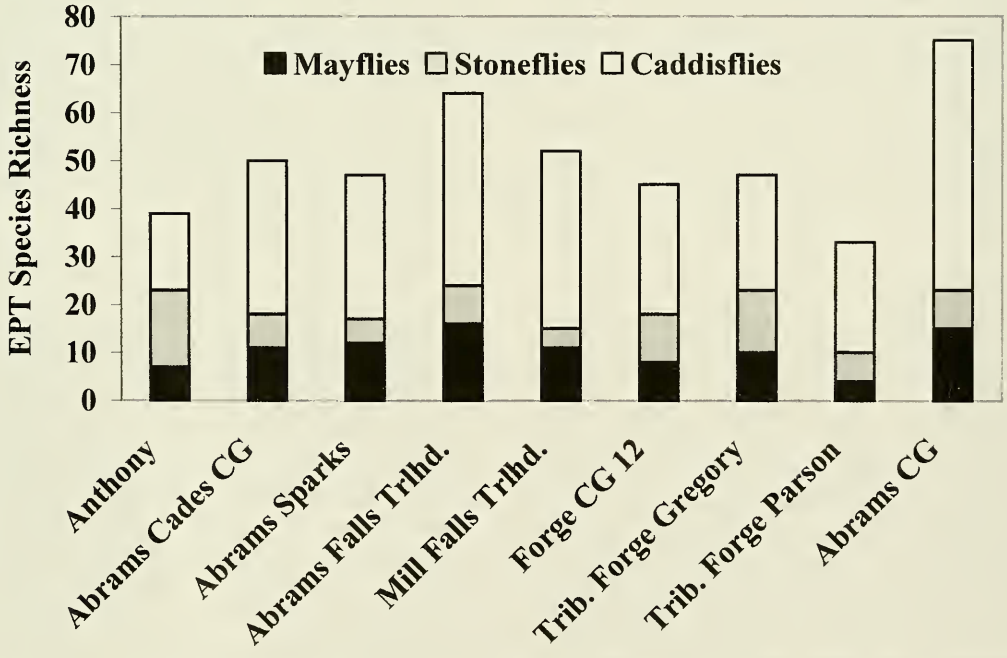
Several stream locations in GRSM are routinely monitored using immature life-stages with identification being facilitated using important works such as Brigham et al. (1982). Although many immatures of EPT species have been associated with adults, a large component remains undescribed or underdescribed; therefore, these data are insufficient to inventory GRSM EPT species. ATBI permanent plots (see Sharkey 2001), using Malaise traps, have provided some adult EPT. Small, systematics-oriented projects have also helped to expand the number of known species. However, basin-wide inventories for adults are necessary to accurately determine the EPT species that occur in GRSM and to associate species with biotic and abiotic factors for predictive purposes.

The objective of this study was to conduct an intensive inventory of EPT in the Abrams Creek drainage during early and midsummer months. This drainage was chosen after the authors reviewed specimens at the Illinois Natural History Survey (INHS) insect collection. Plecoptera alone constituted 600 records, and georeferencing of these locations demonstrated a hole in coverage west and south of Cades Cove—the Abrams Creek drainage. Charles Parker, an aquatic entomologist working in GRSM, confirmed that a study of this drainage would help close a gap in information for streams in GRSM.

Materials and Methods

Nine sites (Table 1, Fig. 1) were repeatedly sampled in the Abrams Creek drainage





Figs. 1–2. 1, (top) EPT sampling locations in the Abrams Creek drainage of the Great Smoky Mountains National Park, summer 2001. 2, (bottom) EPT species richness at nine locations in the Abrams Creek drainage of Great Smoky Mountains National Park, summer 2001.

between 25 May and 22 July 2001. These locations were spread throughout the drainage (Fig. 1) and over an elevational gradient of 454 m. Sites ranged from seepage areas (tributaries of Forge Creek) to a 30 m-wide reach of Abrams Creek at Abrams Creek Campground.

Most reaches were sampled using a Bioquip™, 12-v, ultraviolet light. Effort was standardized by time (approximately one hour beginning at sunset), by reflective sheet size, and by common weather conditions. Often, several sites were sampled in a single evening, necessitating the use of DC timers that permitted remote lighting of traps. Two trays with 80% EtOH were positioned at the bottom of the sheet to capture insects. At attended sites, mayfly subimagoes (a subadult with hair-covered wings that molts to an imago) were captured and stored in a container until transformation. Additionally, males of perlid and perlodid stoneflies were captured and their intromittent organ extruded to facilitate species identification. Anthony Creek was sampled using sweep-netting and handpicking during daylight hours, with the exception of one ultraviolet trap event. Night sampling was avoided due to higher than normal bear activity in that area. Hence, the results at this site are not strictly comparable to that of other sites. Geographic coordinate data were captured using a Garmin™ 12XL at each site.

Some Abrams Creek Campground trap events produced in excess of 5,000 specimens. Consequently, subsampling at 25% was conducted inconjuction with a search for large and rare taxa. An extraordinary event occurred on 22 July necessitating an overall 1/16 subsample rate for microcaddisflies, producing 797 specimens from an estimated 12,832 hydroptilids. Full sample abundance was estimated at 51,328 individuals. For this site, species richness values are reflective of specimens actually inspected and no effort was made to estimate richness based on total sample abundance. No subsampling occurred for other sites.

Specimens were identified to species when possible. Often, only the males of species could be identified. Females were determined where descriptions existed or where it seemed that color pattern, size, or wing veination was consistent with males of known identity. Specimens are housed in the INHS insect collection and are denoted as GRSM and ATBI related specimens. Specimen records are available via the Internet at http://ctap.inhs.uiuc.edu/insect/search.inhs.asp.

Results

Forty-five site visits were made in the Abrams Creek drainage during this project (Table 1), resulting in 35,710 identified specimens. This project recorded 164 EPT species (Table 2). Most species were caddisflies (56.7%), with the remainder evenly split between mayflies and stoneflies.

Heptageniid mayflies were especially species rich (17), while baetids, ephemerellids, and leptophlebiids provided only five, four, and two species respectively. The latter three families were drastically under represented in our samples compared to the regional species pool (Unzicker and Carlson 1982). The dominance of subimagoes in our unattended ultraviolet traps has undoubtedly reduced taxonomic resolution in these families. Morse et al. (1989), working in similar elevations straddling the North and South Carolina border collected 29 mayfly species with low representation in the same families.

Stoneflies were dominated by perlids (10 species) and perlodids (9). The Chloroperlidae (six species) and Leuctridae (four) were probably under represented (Unzicker and McCaskill 1982). Ultraviolet light collections and sweep-netting frequently produced many more females than males in these families, often limiting taxonomic resolution beyond genus. Nelson (1996) conducted a similar inventory, but with immatures, in the Little Pigeon River of neighboring Sevier County, Tennessee. He reported 29 stonefly taxa over a year-long

effort. His use of immatures limited determinations to genus in some species rich groups such as *Alloperla* and *Leuctra*.

Caddisflies were represented by 93 species. Surprisingly, microcaddisflies (Hydroptilidae) were the most diverse family with 17 species. Until this study, few hydroptilids were reported from GRSM (C. Parker, personal communication) and were not thought to be a rich component of the fauna. Leptocerids and hydropsychids provided 15 and 14 species respectively. Morse et al. (1989) reported a similar, but more diverse, fauna from comparable elevations. Much of the increase in diversity in their study was attributable to continued sampling into the fall season when adults of *Pycnopsyche* and *Neophylax* were available. Otherwise, the distribution of species among families, with hydroptilids, hydropsychids, and leptocerids providing the bulk of the species, was comparable to the present study.

Species richness varied greatly across sites (Table 2, Fig. 2). Abrams Creek at Abrams Creek Campground produced the greatest number of EPT species. This richness is undoubtedly due to many diverse habitats, including long, placid runs, undercut banks, and deep pools not common in other sections of the watershed. Abrams Creek at Abrams Falls Trailhead also produced many species. This is the only reach with an intact flatwoods, an area of minimal gradient that is heavily forested and well protected from foot traffic. This site shares many species with Abrams Creek Campground such as several long-horn and microcaddisflies, but also offers some distinctness such as a large population of *Cheumatopsyche oxa* Ross found only in the flatwoods during this study.

Significant Finds

Species were compared to published literature and electronic species lists including Berner (1977), Brigham et al. (1982), DLIA list for aquatic insects (www.discoverlife.org/nh/cl/GSMNP/aquatic_insects_GSMNP.html#overview), Etnier et al. (1998), Lenat and Penrose (1987), Long and Kondratieff (1996), Mayfly Central (www.entm.purdue.edu/entomology/mayfly/mayfly.html), NatureServe (www.natureserve.org), and Pescador et al. (1999) to determine new GRSM and Tennessee state records. A discussion of the more significant finds follows.

Ephemeroptera

Caenidae

Caenis anceps Traver.—Taken from Abrams Creek Campground. Known from central and eastern Tennessee (Long and Kondratieff 1996, Provonsha 1990). A new GRSM record.

Caenis nr. *mccafferti* Provonsha.—Four females from Abrams Creek Campground resemble *Caenis mccafferti* Provonsha, but lack the fleshy, fingerlike posteromedial projection of abdominal tergite two of this species (A. Provonsha, personal communication). More specimens are needed to determine its identity.

Ephemerellidae

Ephemerella invaria (Walker).—One male from Tributary to Forge Creek at Gregory Ridge Trail. Initially identified as *E. fratercula* McDunnough and recently synonymized with *E. invaria* (Jacobus and McCafferty 2003). Known locally from eastern Tennessee (Long and Kondratieff 1996). A new park record.

Serratella molita (McDunnough).-Abundant in lower Abrams Creek. Known from central and eastern Tennessee (Allen and Edmunds 1963, Long and Kondratieff 1996) and North and South Carolina (Jacobus and McCafferty 2002). Jacobus and McCafferty (2002) recently synonymized with *Serratella serratoides* (McDunnough) with this species. A new GRSM record.

Ephemeridae

Ephemera varia Eaton.—Found at Sparks Lane and Mill Creek. Several Tennessee records reported (Long and Kondratieff 1996). Southeastern records are gen-

Table 2. Ephemeroptera, Plecoptera, and Trichoptera from nine repeatedly collected locations in the Abrams Creek drainage of the Great Smoky Mountains National Park, summer 2001. Sites 1 = Anthony, 2 = Abrams, Cades Cove CG, 3 = Abrams, Sparks, 4 = Abrams, Fall Trailhead, 5 = Mill, Falls Trailhead, 6 = Forge CG12, 7 = Trib. Forge Gregory, 8 = Trib. Forge Parson, 9 = Abrams CG.

	Sites									
	1	2	3	4	5	6	7	8	9	Sum
Ephemeroptera										
Baetidae spp.									60	60
Acentrella turbida				2					628	630
Acerpenna pygmaea				1						1
Baetis brunneicolor	1									1
Baetis flavistriga			1		28				10	39
Baetis intercalaris									53	53
Baetis sp.		7	1		1	2			1	12
Caenidae										
Caenis anceps				1					138	139
Caenis n.sp.									4	4
Ephemerellidae spp.			13	104	32				1	150
Ephemerella dorothea						3				3
Ephemerella hispida							1			1
Ephemerella invaria							1			
Ephemerella sp.		2	2	1	17	9				31
Serratella serrata				18						18
Serratella molita		5	6	6	6				497	520
Serratella sp.		1							5	6
Ephemeridae										
Ephemera guttulata								1		1
Ephemera varia			1		4					5
Heptageniidae										
Cinygmula subaequalis	13									13
Epeorus dispar	2									2
Epeorus vitreus		95	25	332	42	3	4	1	84	586
Heptagenia marginalis									17	17
Leucrocuta aphrodite				5	2				205	212
Leucrocuta juno		59	968	15	312		1		3	1,358
Leucrocuta thetis	6					5	1			12
Nixe spinosa			1			1	2			4
Stenacron carolina	1			2				1		4
Stenacron interpunctatum			1						68	69
Stenacron pallidum		3								3
Stenacron sp.	2	3	1		2					8
Stenonema ithaca		1							105	106
Stenonema meririvulanum				1						1
Stenonema modestum		4		3					62	69
Stenonema pudicum		10	63	5	5	1				84
Stenonema terminatum	1							1		2
Stenonema vicarium				3					92	95
Stenonema sp.		1				2	1	2	5	11
Isonychiidae										
Isonychia bicolor		13	1	1						15
Isonychia serrata				1						1
Isonychia sp.			1	3	1	1	1		17	24
Leptophlebiidae										

Table 2. Continued.

	Sites									
	1	2	3	4	5	6	7	8	9	Sum
Habrophlebiodes americana		1								1
Paraleptophlebia assimilis							2			2
Paraleptophlebia sp.	1		1			1				3
Siphlonuridae										
Siphlonurus typicus			1							1
Leuctridae										
Leuctra alexanderi	14						4	5		23
Leuctra ferruginea		3					3	1		7
Leuctra grandis								1		1
Leuctra carolinensis	2					6				8
Leuctra sp.	19	2				6	13	7		47
Nemouridae										
Amphinemura nigritta								1		1
Amphinemura wui	20	2				8	8	3		41
Chloroperlidae										
Alloperla caudata			1							1
Alloperla nanina	1					1	1			3
Alloperla neglecta			1							1
Alloperla usa	1									1
Alloperla sp.	2	1	3		1	1				8
Suwallia marginata	1									1
Sweltsa mediana		5								5
Sweltsa sp.	6	14				2	1		1	24
Perlidae										
Acroneuria abnormis	5	2		3	11	16	21		47	105
Acroneuria carolinensis				2						2
Acroneuria filicis				1	1				2	4
Beloneuria georgiana	2						1			3
Eccoptura xanthenes						6	10			16
Neoperla coosa									11	11
Perlesta decipiens									13	13
Perlesta frisoni							1			1
Perlesta nelsoni			2	3					15	20
Perlesta placida				4					38	42
Perlodidae										
Diploperla duplicata		1								1
Isoperla dicala				3					2	5
Isoperla frisoni				5						5
Isoperla holochlora	7		1	17	5	9	3			42
Isoperla sp. M8							1			1
Isoperla sp.				4						4
Malirekus hastatus	1									1
Remenus bilobatus	3		1			2				6
Yugus arinus	1									1
Yugus bulbosus	3					1				4
Yugus sp.	2									2
Peltoperlidae										
Tallaperla anna							1			1
Tallaperla laurie							6	1		7

Table 2. Continued.

	Sites									
	1	2	3	4	5	6	7	8	9	Sum
Tallaperla maria	2	24								26
Tallaperla sp.	2									2
Viehoperla ada						1				1
Pteronarcyidae										
Pteronarcys scotti	1									1
Brachycentridae										
Micrasema wataga			1	526	169		1		334	1,031
Micrasema sp.		1						1		2
Calamoceratidae										
Anisocentropus pyraloides									2	2
Heteroplectron americanum							1			1
Glossosomatidae										
Agapetus rossi				24					206	230
Agapetus tomus		212	183	136	82				1,893	2,506
Agapetus minutus		1								1
Agapetus sp.			2,566	1,818	1,093					5,477
Glossosoma nigrior		1	3	2	8	1	1			16
Goeridae										
Goera calcarata		1	4	100	28				52	185
Goera n.sp.		1				3		1		5
Helicopsychidae										
Helicopsyche borealis				1					71	72
Hydropsychidae										
Arctopsyche irrorata	2									2
Ceratopsyche macleodi	87									87
Ceratopsyche morosa		2	5			1				8
Ceratopsyche slossonae			7	209	181	9	5	16		427
Ceratopsyche sparna	2	57	78	279	110	11	3		181	721
Ceratopsyche sp.			2				1			3
Cheumatopsyche nr. goera									1	1
Cheumatopsyche harwoodi		305	236	136	511				931	2,119
Cheumatopsyche helma									27	27
Cheumatopsyche oxa				211	60					271
Cheumatopsyche sp.			364				1		858	1,223
Diplectrona modesta	1	111			8	213	262	123		718
Hydropsyche betteni			4	6	6					16
Hydropsyche depravata				11	4					15
Hydropsyche betteni or *depravata*		2	16	17						35
Hydropsyche simulans				84					16	100
Hydropsyche sp.						13	2			15
Parapsyche cardis	7					25	10	1		43
Hydroptilidae										
Hydroptila alabama		1							3	4
Hydroptila nr. *amoena*		1		1	1					3
Hydroptila armata				4	3				15	22
Hydroptila callia				4					10	14
Hydroptila chattanooga				6						6
Hydroptila delineata									19	19
Hydroptila fiskei		1		27	1				163	192
Hydroptila grandiosa			1	113	23				7,151	7,288

Table 2. Continued.

	Sites									
	1	2	3	4	5	6	7	8	9	Sum
Hydroptila hamata			1	40	8				748	797
Hydroptila talladega		1		1	1					3
Hydroptila sp.		4	1	52	7			2	197	263
Mayatrichia ayama									1	1
Ochrotrichia graysoni									2	2
Ochrotrichia sp.					1				7	8
Oxyethira novasota									2	2
Oxyethira pallida									2	2
Oxyethira sp.					1				3	4
Palaegapetus celsus						3				3
Stactobiella delira		1								1
Stactobiella martynovi		4	1		1					6
Stactobiella sp.		15		1				1		17
Lepidostomatidae										
Lepidostoma lydia	1									1
Lepidostoma modestum group		2								2
Lepidostoma ontario								4	1	5
Lepidostoma pictile						3	1			4
Lepidostoma tibiale				1					17	18
Lepidostoma togatum									4	4
Lepidostoma (*Mormomyia*) sp.	1	2	1			4	5	7		20
Leptoceridae										
Ceraclea cancellata			1						5	6
Ceraclea flava									119	119
Ceraclea nepha									1	1
Ceraclea tarsipunctata			1	1					16	18
Ceraclea transversa		8	8	5	6	4	1	5	8	45
Ceraclea sp.			7					1	2	10
Leptocerus americanus									1	1
Mystacides sepulchralis				5					3	8
Nectopsyche exquisita									57	57
Oecetis avara				32	1				318	351
Oecetis inconspicua		5	2	2	1				804	814
Oecetis persimilis			1	26	5				139	171
Setodes stehri				92	3				1,455	1,550
Triaenodes ignitus		4	2	12	31				2	51
Triaenodes perna		1							9	10
Triaenodes taenius					1	2				3
Limnephilidae										
Pseudostenophylax uniformis	1					1		3		5
Molannidae										
Molanna blenda				1						1
Molanna ulmerina			1	1	1				6	9
Odontoceridae										
Psilotreta amera								3		3
Psilotreta sp.							1			1
Philopotamidae										
Chimarra aterrima									2	2
Chimarra augusta									3	3
Chimarra socia									193	193

Table 2. Continued.

	Sites									
	1	2	3	4	5	6	7	8	9	Sum
Chimarra sp.									129	129
Dolophilodes distinctus		6	19	5	10	8	4	6		58
Dolophilodes major	1					11	7	1		20
Dolophilodes sp.		16		3	16	7		3		45
Wormaldia moesta		1				2		4		7
Wormaldia sp.						2	2	1		5
Phryganeidae										
Ptilostomis ocellifera							1			1
Polycentropodidae										
Nyctiophylax affinis									21	21
Nyctiophylax banksi									1	1
Nyctiophylax celta								1	81	82
Nyctiophylax nephophilus		4		1	3	3		1		12
Nyctiophylax sp.		39		11	2	3	2		320	377
Plectronemia crassicornis			1		1					2
Polycentropus cinereus		37	5	3	21	16	18	2	3	105
Polycentropus confusus		6	16	3	8		2	3	13	51
Polycentropus maculatus						1				1
Polycentropus sp.			4		1	3	1		2	11
Psychomyiidae										
Lype diversa	26	20	1	5	11	7	2	5	1	78
Psychomyia flavida		1,446	47	419	260	1		18	17	2,208
Rhyacophilidae										
Rhyacophila atrata	1									1
Rhyacophila carolina	3	2	1		1	1	3	2	1	14
Rhyacophila carpenteri							2	2		4
Rhyacophila fuscula		7		11	15	11		1	5	50
Rhyacophila glaberrima	4						1			5
Rhyacophila nigrita	24					4				28
Rhyacophila teddyi	2					1				3
Rhyacophila torva	2									2
Rhyacophila vibox			1				1			2
Rhyacophila sp.			5				1	1		7
Sericostomatidae										
Fattigia pele						2				2
Site Totals	291	2,595	4,705	5,010	3,195	487	458	276	18,874	35,710
Ephemeroptera	7	11	12	16	11	8	9	4	15	35
Plecoptera	16	7	5	8	4	10	13	6	8	36
Trichoptera	16	32	29	40	37	27	24	23	52	93
EPT Total	39	50	46	64	52	45	46	33	75	164

erally from "high mountain areas" McCafferty (1975). A new GRSM record.

Heptageniidae

Epeorus vitreus (Walker).—Abundant in larger streams. A rare find in Tennessee (Long and Kondratieff 1996). A new GRSM record.

Leucrocuta aphrodite (McDunnough).—Abundant in lower Abrams Creek. Known from the Southeast (Berner 1977) and Tennessee (Long and Kondratieff 1996). First confirmed record from GRSM, but see Berner's (1977) nonspecific record of Sevier County, Tennessee.

Leucrocuta juno (McDunnough).—Most commonly encountered *Leucrocuta* in middle reaches. Known from the Southeast (Berner 1977) and central and eastern Tennessee (Long and Kondratieff 1996). First confirmed GRSM record (again, see Berner).

Leucrocuta thetis (Traver).—Relegated to higher elevation sites. Possibly rare in Tennessee (Long and Kondratieff 1996), but known from GRSM.

Stenonema ithaca (Clemens and Leonard).—Abundant at Abrams Creek Campground. Known from central and eastern Tennessee (Bednarik and McCafferty 1979, Long and Kondratieff 1996). New GRSM record.

Nixe spinosa (Traver).—Four males taken from three locations. Known from northwestern North Carolina (Unzicker and Carlson 1982, Pescador et al. 1999). A new Tennessee and GRSM record.

Isonychiidae

Isonychia bicolor (Walker).—Fifteen males taken in middle reaches of Abrams Creek. Known from Tennessee (Long and Kondratieff 1996). A new GRSM record.

Leptophlebiidae

Paraleptophlebia assimilis (Banks).—Two specimens taken from Tributary to Forge Creek at Gregory Ridge Trail. Known from the Southeast (Berner 1977), including Tennessee (Long and Kondratieff 1996). A new GRSM record.

Siphlonuridae

Siphlonurus typicus Eaton.—One male taken from Sparks Lane. Not known from the Southeast (Berner 1977, Pescador et al. 1999), but reported from Indiana and Massachusetts (Provonsha and McCafferty 1982), the Midwest and eastern Canada (Randolph and McCafferty 1998), and New York (Jacobus and McCafferty 2001). A new Tennessee and GRSM record.

PLECOPTERA

Perlidae

Perlesta decipiens (Walsh).—Thirteen adults from Abrams Creek Campground. A widespread, eastern species (Stark 1989). A new Tennessee and GRSM record. Any reference to species of *Perlesta* prior to Stark's (1989) revision must be viewed with skepticism.

Perlesta placida (Hagen).—Several specimens taken from Abrams Creek at the Falls Trailhead and at Abrams Creek Campground. Widespread in Atlantic and Gulf Coastal Plains states (Stark 1989). A new Tennessee and GRSM record.

Neoperla coosa Smith and Stark.—Eleven adults taken at Abrams Creek Campground. A recently described species from northern Alabama (Smith and Stark 1998). A new Tennessee and GRSM record.

Isoperla n.sp. M8.—One specimen taken from Tributary to Forge Creek at Gregory Ridge Trail. An undescribed, light colored species, superficially similar to *I. holochlora* (Klapálek). Stan Szczytko is currently reevaluating the genus in eastern North America. The above naming convention is his. A new Tennessee and GSRM record.

TRICHOPTERA

Hydropsychidae

Cheumatopsyche helma Ross.—Twenty-seven specimens taken from Abrams Creek Campground. Known from four locations in Tennessee, Kentucky, and North Carolina (Etnier et al. 1998). Not a new GRSM record, but it is rare.

Cheumatopsyche oxa Ross.–Taken from Abrams and Mill creeks at the Falls Trailhead. Gordon (1974) reported it from Midwestern and eastern USA. Known from eastern and middle Tennessee (Etnier et al. 1998). A new GRSM record.

Hydropsyche simulans Ross.—Taken from Abrams Falls Trailhead and Abrams Creek Campground. Widespread in Tennessee (Etnier et al. 1998). A new GRSM record.

Hydroptilidae

Hydroptila alabama Harris and Kelley.–Taken from Abrams Creek Campground. Known from Alabama (Harris and Kelley 1984) and Polk County, Tennessee (Etnier et al. 1998). A new GRSM record.

Hydroptila nr. *amoena* Ross.—Three males from Cades Cove area. Steve Harris (personal communication) states that he has not been able to identify them and that they may be new.

Hydroptila armata Ross.—Collected from lowest elevation sites. Known from middle and eastern Tennessee (Etnier et al. 1998). A new GRSM record.

Hydroptila chattanooga Frazer and Harris.—Abrams Falls Trailhead yielded six males. Described from Alabama, additional specimens from Ohio and Pennsylvania (Frazer and Harris 1991). A new Tennessee and GRSM record.

Hydroptila fiskei Blickle.—Taken from larger reaches of the drainage. A new Tennessee and GRSM record.

Mayatrichia ayama Mosely.—One specimen taken at Abrams Creek Campground. Etnier et al. (1998) reported it from nearby Bradley and Monroe counties. A new GRSM record.

Ochrotrichia graysoni Parker and Voshell.—Two males taken at Abrams Creek Campground. Originally described from Virginia (Parker and Voshell 1980). A new Tennessee and GRSM record.

Oxyethira novasota Ross.—Two males taken from Abrams Creek Campground. Known regionally from northern Alabama (Harris 1986, Harris et al. 1991) and eastern Tennessee (Etnier et al. 1998). A new GRSM record.

Oxyethira pallida (Banks).—Two males taken from Abrams Creek Campground. A second record for Tennessee (Etnier et al. 1998), a first for GRSM.

Leptoceridae

Ceraclea flava (Banks).—Many individuals taken from Abrams Creek Campground. Reported from middle and eastern Tennessee (Etnier et al. 1998). A new GRSM record.

Ceraclea nepha (Ross).—One male taken from Abrams Creek Campground. Known from Tennessee, including nearby Polk County (Etnier et al. 1998). A new GRSM record.

Ceraclea transversa (Hagen).—Widely distributed in the drainage. Reported from middle and northeastern Tennessee (Etnier et al. 1998). A new GRSM record.

Leptocerus americanus (Banks).—One male taken at Abrams Creek Campground. Known from east-central Tennessee (Etnier et al. 1998). A new GRSM record.

Oecetis avara (Banks).—Abundant in the three lowest elevation reaches Abrams Creek. Widespread in Tennessee (Etnier et al. 1998). A new GRSM record.

Triaenodes perna Ross.—Small numbers collected at Cades Cove and Abrams Creek campgrounds. Known from central and eastern Tennessee (Etnier et al. 1998). A new GRSM record.

Molannidae

Molanna ulmerina Navas.—Collected at low elevation. Known from a single east-central Tennessee location (Etnier et al. 1998). A new GRSM record.

Philopotamidae

Chimarra aterrima Hagen.— The genus is not well represented in GRSM. It appears that *Dolophilodes* and *Wormaldia* replace it above 400 m. Two males taken at Abrams Creek Campground. Known from eastern and central Tennessee (Etnier et al. 1998). A new GRSM record.

Chimarra augusta Morse.—Three males taken at Abrams Creek Campground. In Tennessee, known only from Bradley County (Etnier et al. 1998). A new GRSM record.

Chimarra socia Hagen.—Abrams Creek Campground produced many specimens. Known from scattered locations in Tennes-

see, including adjacent Monroe County (Etnier et al. 1998). A new GRSM record.

Polycentropodidae

Nyctiophylax affinis (Banks).—Twenty-one males taken at Abrams Creek Campground. Known from middle Tennessee (Etnier et al. 1998). A new GRSM record.

Nyctiophylax celta Denning.—Eighty-two males taken at Tributary of Forge Creek at Parson Branch and at Abrams Creek Campground. Etnier et al. (1998) reported it from eastern Tennessee, including Blount County. A new GRSM record.

Plectronemia crassicornis (Walker).—Two females taken from Sparks Lane and Mill Creek. Known from middle Tennessee (Etnier et al. 1998). A new GRSM record.

Rhyacophilidae

Rhyacophila vibox Milne.—One female each were taken at Sparks Lane and at Tributary to Forge Creek on Gregory Ridge Trail. Known from eastern Tennessee (Etnier et al. 1998). A new GRSM record.

Discussion

This large project contributed eight new Tennessee and 39 new GRSM records. Most of these were recorded from Abrams Creek Campground. Other large streams may offer more unknowns for GRSM. Several other significant finds originated from the flatwoods portion of Cades Cove at the confluence of Abrams and Mill creeks. These areas are easily accessible and pose a conundrum as to how they have been overlooked through the 70 year history of the park. It is probable that most systematists have avoided Cades Cove and the western end of GRSM because it is heavily traveled and constitutes some of the lowest elevations.

Several EPT specimens represent undescribed species known to specialists. These include *Isoperla* sp. M8 and *Goera* sp. Additionally, specimens of *Caenis* nr. *mccafferti* and *Hydroptila* nr. *amoena* may represent new species. More specimens and further study will be required to solve these questions.

Our study has also documented new locations for several rarely collected species. Rarity is defined here as species being known from a relatively few published locations. Since designation of species as rare depends on available data, those with unpublished records may disagree with our interpretations. Publication of those records in paper or digital format would increase the accuracy of determinations of rarity.

Rare mayflies include *Epeorus vitreus, Leucrocuta thetis,* and *Nixe spinosa.* The distribution of *Epeorus vitreus* is not well known (NatureServe) and we provide several records. *Leucrocuta thetis* is given an S3 (vulnerable due to a restricted range) status in Tennessee by NatureServe. We have provided three GRSM locations. *Nixe spinosa* is thought of as a North Carolina endemic and has been listed by NatureServe as N3 (vulnerable due to a restricted range). The species has no imperilment status in North Carolina. We provide the first records for Tennessee.

There were no rare stoneflies collected, but five rare caddisflies are discussed. *Ceratopsyche macleodi* was originally described from North Carolina (Flint 1964) and Etnier et al. (1998) gave a nonspecific reference of eastern Tennessee. Anthony Creek supports a large population of this species. NatureServe lists *Cheumatopsyche helma* as S1 (Alabama and Pennsylvania-critically imperiled) to S3 (Tennessee-vulnerable) to SH (Kentucky-extirpated). A small population was taken at Abrams Creek. *Hydroptila chattanooga* has only been reported from five locations in Alabama, Ohio, and Pennsylvania (Frazer and Harris 1991). We have six males from the a low gradient, flatwoods section of Abrams Creek. NatureServe rates *Hydroptila talladega* as S1 in Alabama, with insufficient data for other states where it occurs (Georgia, Kentucky, North Carolina, and South Carolina). It was listed by Morse et al. (1993) as rare and vulnerable. We report it from

three locations in the drainage. *Chimarra augusta* is rated at S1 in Alabama, but has no rating in other states in which it occurs (South Carolina, Tennessee, Virginia, West Virginia) (Armitage 1991).

Our data suggest that the potential for discovery of new state and GRSM records is greatest in mayflies and caddisflies. Future work on these and other aquatic insects should focus on southwestern GRSM drainages and on the streams above Lake Fontana. These areas are less accessible than any other region in GRSM and may hold additional significant records.

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